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(54) Method for manufacturing chocolate

(57) A chocolate is manufactured without employing traditional time consuming mixing and refining operations by passing cocoa liquor and milk solids, if a milk chocolate is required, through a scraped heat exchanger at a temperature of 35 to 145°C under a reduced pressure of down to 5 torr to remove undesirable flavours and reduce the water content of the material to 0.5 to 1% by weight. The material is then mixed with sugar having a particle size distribution such that 98% at least by weight has a particle size less than 30 microns and passed at least once through a gap of 25 to 600 microns between relatively rotating shearing elements.

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SPECIFICATION

Method for manufacturing chocolate

This invention relates to a method for manufacturing chocolate.

Traditionally, quality chocolate is manufactured by mixing the chocolate-making ingredients together, and refining and then conching the resultant mixture. The basic chocolate-making ingredients are cocoa liquor, cocoa butter and sugar in the case of dark chocolate, and these ingredients plus milk solids in the case of milk chocolate. The precise ingredient and the proportions thereof vary depending upon the type of chocolate to be produced and the country for which the chocolate is intended (in this latter respect, regard is had to national taste and the prevailing regulations). The chocolate mixture is refined in order to reduce the particles to the required size so as to impart a smooth texture to the chocolate. Refining is traditionally carried out by means of refining rolls and the gap between the rolls is set to control the particle size precisely. Conching traditionally involves batch treatment of the refined material in a conch or shell-shaped vessel having a flat bed upon which heavy rollers move backwards and forwards. More recently, continuous conching has been employed. The conching operation is normally effected at a slightly elevated temperature (e.g. 46–52°C for milk chocolate and 60–70°C for dark chocolate). The conching operation is essentially to develop the flavour and to effect an intimate mix of the ingredients but does not reduce the particle size appreciably. However, for quality chocolate, a conching operation is regarded as being essential. Conching times are very extended (10–96 hours depending upon the type of chocolate being produced).

It will be appreciated from the above that the traditional chocolate-making method is expensive both in terms of process time and in terms of equipment cost.

It is an object of the present invention to provide an improved method which is relatively simple and quick and which enables a quality chocolate to be produced.

According to the present invention, there is provided a method of manufacturing chocolate comprising the steps of feeding cocoa liquor and, if a milk chocolate is desired, mild solids to a scraped heat exchanger operating at a temperature of 35–145°C under a reduced pressure of down to 5 torr so as to remove undesirable flavours and to produce a material having a water content of 0.5–1% by weight, mixing said material with sugar having a particle size distribution such that at least 98% by weight of the sugar has a particle size less than 30 microns, and passing such mixture at least once through a shearing device(s) having relatively rotating shearing elements between which there is defined a gap of 25–600 microns through which the mixture passes.

If desired, and particularly if the moisture content of the starting ingredient(s) is low, 1–2% by weight of water may be included in the material passed to the heat exchanger in order to improve removal of the undesirable (e.g. acidic) flavours.

Cocoa butter may be added to the material passed to the heat exchanger if the amount of cocoa butter in the cocoa liquor is insufficient for the required recipe. Additionally or alternatively, cocoa butter may be added after evaporation but before milling.

The scraped heat exchanger preferably takes the form of a climbing film evaporator and serves to remove undesirable flavours and so effects flavour development in the manner of the traditional conching operation. The term "scraped heat exchanger" as used herein includes a so-called "wiped" heat exchanger.

The operating temperature in the scraped heat exchanger depends upon the type of chocolate to be produced. For the production of milk chocolate, a temperature of 50 to 80°C is generally used, most preferably the temperature is 60 to 65°C. For the production of plain chocolate, higher temperatures can be employed, e.g. 50 to 110°C, preferably 70 to 100°C.

The residence time of the material in the heat exchanger may be 1 to 20 minutes although 2 to 10 minutes will generally be used. The pressure at which the heat exchanger will operate depends upon the residence time and temperature as well as upon the type of chocolate. The pressure is preferably 5 to 250 torr although it is most preferably 5 to 40 torr for a milk chocolate or 25 to 50 torr for a plain chocolate.

The shearing device preferably takes the form of a mill which has inner and outer partially toothed conical members defining said shearing elements wherein the mixture being processed passes between the conical surfaces of said members. In the shearing device, a high shear is imparted to the ingredients which are thereby intensively mixed to the required homogeneous texture and also any remaining large particles will be reduced to the required particle size to develop the required texture and thus the shearing device serves to perform the mixing and refining operations in a traditional chocolate making process.

In order to develop the required texture, it will normally be necessary to effect more than one shearing operation on the mixture in order to "work" the mixture. This may be effected by passing the mixture more than once through the same shearing device, although for continuous production, it will be effected by passing the mixture through a

series of shearing devices. Typically about 4 or 5 shearing operations will be provided with the gap between the shearing elements being decreased at each shearing operation concomitantly with a decrease in the rate of relative rotation of the shearing elements.

The gap between the shearing elements is preferably 30 to 450 microns and most preferably 150 microns. Preferably, the rate of flow of the materials through the rotary mill and the rotational speed of the mill are arranged so as to give a temperature rise not exceeding 20°C.

As mentioned above, the sugar has a particle size distibution such that at least 98% by weight of the sugar has a particle size less than 30 microns. However, it is preferred for at least 90% by weight of the sugar to have a particle size of greater than 5 microns because this can improve the ease of processing certain chocolate compositions. A large proportion of very fine sugar particles (5 microns or less) increases the viscosity of the mixture. However, such fine particles are more acceptable in chocolate compositions having a high fat content.

Preferably, the sugar has a particle size distribution such that at least 98% by weight of the sugar has a particle size less than 25 microns and 90% by weight of the sugar has a particle size greater than 8 microns.

Preferably, the sugar is so-called microcrystalline sugar wherein the particles are single crystals.

The Applicants have found that the use of sugar of the size specified above is essential in the method of their invention because, by its use, the need for breaking-down sugar particles so that they cannot be felt in the mouth is almost entirely avoided. The use of microcrystalline sugar is particularly preferred because it can be obtained with the correct particle size distribution. If granulated sugar is ground or milled to reduce the particle size thereof, it generally has to be classified to remove large quantities of particles which are too fine and which would lead to high viscosity in the chocolate which creates processing difficulties. A typical example of microcrystalline sugar is one in which not more than 2% by weight of the sugar crystals have a crystal size greater than 30 microns and not more than 10% by weight of the crystals have a crystal size less than 5 microns. The microcrystalline sugar may be made up of crystal agglomerates. The agglomerates of crystals may be either broken down into individual crystals before mixing with the other ingredients or may be broken down during the mixing process. In the latter case, the energy required to break down the crystal agglomerates into individual crystals is relatively small and therefore does not produce an unacceptable overheating of the mixture.

The particle size of the cocoa liquor solids preferably lies within the ranges specified for the sugar.

The proportions of the raw ingredients employed in the method depend upon the type of chocolate which is to be manufactured and the country in which the chocolate is intended to be sold. However, typically, where a milk chocolate is to be manufactured, the proportions of the raw ingredients will be as follows:—

2.5–10%,	preferably 5% by weight of non-fat cocoa solids.
16–35%,	preferable 22% by weight of cocoa butter and cocoa butter substitute.
14–40%,	preferably 27% by weight of full cream milk solids.
30–55%,	preferably 45% by weight of microcrystalline sugar.
0–1.5%,	preferably 0.6% by weight of emulsifier (e.g. lecithin) and flavouring.
0–2%,	preferably 0.4% by weight of added water.

Where a plain chocolate is to be manufactured, the porportions of the ingredients will preferably be as follows:—

12–25%,	preferably 14% by weight of non-fat cocoa solids.
18–40%,	preferably 30% by weight of cocoa butter and cocoa butter substitutes.
40–77%,	preferably 55% by weight of microcrystalline sugar.
0–15%,	preferably 0.6% by weight of emulsifying agent (e.g. lecithin) and flavouring.
0–2%,	preferably 0.4% by weight of water.

An example of a method of manufacturing milk chocolate will now be described.

A mixture of 27% by weight of cocoa liquor (containing 44% by weight of non-fat cocoa solids and which had been repeatedly milled so as to ensure that it was sufficiently smooth to the palate—typically the cocoa solids had a particle size distribution such that at least 98% by weight of the particles had a size less than 30 microns), 61% by weight of full cream milk powder and 12% by weight of additional cocoa butter was mixed and passed through a climbing film evaporator (in this embodiment, a CONVAP evaporator manufactured by Alfa Laval and modified by Bauermeister for cocoa liquor treatment). The residence time in the evaporator was 2 to 10 minutes operating at a product temperature of 50 to 80°C and a vacuum of 25 to 50 torr. This removed undesirable flavour and reduced the total moisture content of the mixture to between 0.5 and 1.0% by weight.

A mixture of 44% by weight of the above treated mixture, 11% of cocoa butter, 45% of

microcrystalline sugar, and flavours was then passed through a cone-in-cone colloid mill acting as a shearing device. In this embodiment, the mill employed was a toothed colloid mill type MZ80 sold under the trade mark "Fryma" by M & M Process Equipment Limited of Hemel Hempstead, Herts, England, which had a modified milling head. The milling head of such a mill usually has inner and outer frusto-conical milling elements which are vertically arranged so that the gap between them decreases to a minimum at the bases of the frusto-cones. The inner element is rotatable relative to the outer which is held against rotation but which is movable axially relative to the inner element so as to enable the gap to be set. Also, in such a milling head, each frusto-conical surface has upper intermediate and lower annular portions. Each portion has a plurality of parallel grooves in its surface, the grooves being spaced apart around the periphery of the surface. The grooves are inclined in the peripheral direction at an acute angle with respect to the axis of the frusto-conical milling element. The grooves increase in number but decrease in width and depth stagewise in going from the upper through the intermediate to the lower portions. The grooves in the intermediate portions are inclined in the opposite sense of the inclination of the grooves in the upper and lower portions. The grooves in one element are inclined with respect to the co-operating grooves in the other element. In the modified milling head, the milling elements are modified so that the lower portions thereof are smooth, i.e. ungrooved, and the upper and intermediate portions have mutually aligned grooves which are of the same width but of different depths, the grooves of the intermediate portions being shallower than those of the upper portions. In such a modified milling head, very little milling takes place and, in some cases where the solids being processed are all sufficiently small, no milling at all may occur. However, a very high shear of the material takes place as it passes through the aforesaid minimum gap between the smooth lower portions of the milling elements. The modified head had a diameter of 80 mm and the mixture was passed through at a rate of 5 to 15 kg/minute. The narrowest or minimum gap between the relatively rotating elements was progressively reduced in successive passes from 300 microns to 25 microns, the rotational speed being correspondingly reduced from 2800 r.p.m. to 700 r.p.m. so that the temperature rise of the mixture passing through the modified mill did not exceed 20°C. In this manner, the mixture was thoroughly worked in a relatively short time compared to traditional mixing and refining operations used in conventional chocolate making. After treatment in the modified mill, the mixture was passed through a cooler (in this embodiment a Fryma Coolmix).

The resultant mixture was then moulded into blocks in the conventional way. The moulded milk chocolate blocks had eating qualities comparable with those produced by traditional chocolate making methods.

In modification, the above process was repeated to produce a plain chocolate using the following ingredients and treatment conditions:—

Cocoa liquor (containing 44% by weight of non-fat cocoa solids which had been repeatedly milled to the required size) was passed through the climbing film evaporator. Residence time was 2 to 5 minutes, operating at product temperatures of 70 to 115°C and vacuum of 25 to 50 torr. This reduced moisture content to 0.5 to 1.0% by weight and also removed undesirable flavours.

A mixture was then made using 32% of the treated cocoa liquor, 12% cocoa butter, 55% of microcrystalline sugar and 1% by weight of a mixture of lecithin and flavouring and this was passed through the modified Fryma mill using the same conditions mentioned previously.

The resultant product was a moulded plain chocolate, which had eating qualities similar to that of a plain chocolate produced by conventional techniques.

CLAIMS

1. A method of manufacturing chocolate comprising the steps of feeding cocoa liquor and, optionally, milk solids, to a scraped heat exchanger operating at a temperature of 35 to 145°C under a reduced pressure of down to 5 torr so as to remove undesirable flavours and to produce a material having a water content of 0.5 to 1% by weight, mixing said material with sugar having a particle size distribution such that at least 98% by weight of the sugar has a particle size less than 30 microns, and subjecting such mixture to shear in at least one operation by passing the mixture through a gap of 25 to 600 microns defined between relatively rotating shearing elements.

2. A method as claimed in claim 1, wherein the heat exchanger operates at a temperature of 35 to 145°C and at a pressure of 5 to 250 torr, the sugar has a particle size distribution such that at least 90% by weight thereof has a particle size greaer than 5 microns, and the shearing elements are milling elements of a rotary mill.

3. A method as claimed in claim 1 or 2, wherein 1 to 2% by weight of water is included in the material passed to the heat exchanger.

4. A method as claimed in any preceding claim wherein cocoa butter is included in the material passed to the heat exchanger.

5. A method as claimed in any preceding claim, wherein cocoa butter is added after evaporation but before shearing.

6. A method as claimed in any preceding claim, wherein the heat exchanger is a climbing film evaporator.

7. A method as claimed in any preceding claim, wherein a milk chocolate is produced and the operating temperature in the heat exchanger is 50 to 80°C.

8. A method as claimed in claim 7, wherein said operating temperature is 60 to 65°C.

9. A method as claimed in any one of claims 1 to 6, wherein a plain chocolate is produced and the operating temperature in the heat exchanger is 50 to 110°C.

10. A method as claimed in claim 9, wherein said operating temperature is 70 to 100°C.

11. A method as claimed in claim 7 or 8, wherein the pressure is 5 to 40 torr.

12. A method as claimed in claim 9 or 10, wherein the pressure is 25 to 50 torr.

13. A method as claimed in any one of claims 1 and 3 to 12, wherein the sugar has a particular size distribution such that at least 90% by weight thereof has a particle size greater than 5 microns.

14. A method as claimed in any preceding claim, wherein the sugar has a particle size distribution such that at least 98% by weight of the sugar has a particle size less than 25 microns and at least 90% by weight of the sugar has a particle size greater than 8 microns.

15. A method as claimed in any preceding claim, wherein said gap is 30 to 450 microns.

16. A method as claimed in claim 15, wherein said gap is 150 microns.

17. A method as claimed in any preceding claim, wherein the rate of flow of material between the relatively rotating elements is such that the material rises in temperature by not more than 20°C.

18. A method as claimed in any preceding claim, wherein the sugar is microcrystalline sugar wherein the particles are single crystals.

19. A method as claimed in claim 1, substantially as hereinbefore described.

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